

AMENDMENTS TO THE CLAIMS

Claim 1 (Currently Amended) A howling suppression device for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the howling suppression device comprising:

a first power spectrum information producing section for producing a first power spectrum according to a first acoustic signal output, as an electric signal, from the first microphone that collects collecting a sound and converts the sound into the electric signal; second acoustic signal obtaining means for obtaining a second acoustic signal that is an electric signal of a sound including at least the intensified sound and not including the target sound;

a second power spectrum information producing section for producing a second power spectrum according to the second acoustic signal; and

a learning control section for, based on the first acoustic signal and the second acoustic signal, detecting a period in which (i) the first microphone is not collecting the target sound, and (ii) the second acoustic signal is indicating the intensified sound or a reverberating sound of the intensified sound, and for outputting a control signal indicating the detected period;

a ratio storing section for storing a ratio of the second power spectrum with respect to the first power spectrum;

a spectrum ratio estimating section for calculating the ratio of the second power spectrum with respect to the first power spectrum when the control signal indicates the detected period, and updating the ratio stored in the ratio storing section according to a predetermined method using the calculated ratio; and

a suppression filter section for (i) estimating a sound component, other than the target sound, that has been mixed in the first acoustic signal, the sound component that has been mixed in the first acoustic signal being estimated by using the first power spectrum, the second power spectrum, and the ratio stored in the ratio storing section, and (ii) suppressing the sound component in the first acoustic signal so as to output only an acoustic signal of the target sound to the amplification section filtering the first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.

Claim 2 (Currently Amended) The howling suppression device according to claim 1, wherein the second acoustic signal obtaining means is a second microphone provided in a sound field in which the first microphone and the loudspeaker are provided, the second microphone not collecting the target sound while collecting at least the intensified sound in the sound field to convert the collected intensified sound into the electric signal that is output the second acoustic signal.

Claim 3 (Currently Amended) The howling suppression device according to claim 1, wherein the second acoustic signal obtaining means is connected to a line that connects the amplification section to the loudspeaker, and obtains, as the second acoustic signal, realized by connecting a line between the amplification section and the loudspeaker with the second power spectrum information producing section so that a signal output from the amplification section is

~~output to the second power spectrum information producing section as the second acoustic signal.~~

Claim 4 (Previously Presented) The howling suppression device according to claim 1, further comprising:

a signal-to-signal delay detecting section for detecting a delay time between the first acoustic signal output from the first microphone and the second acoustic signal; and

a signal delaying section for inputting the second acoustic signal to the second power spectrum information producing section after delaying the second acoustic signal according to the delay time detected by the signal-to-signal delay detecting section.

Claim 5 (Cancelled)

Claim 6 (Currently Amended) The howling suppression device according to ~~claim 1-claim 5~~, wherein:

the learning control section outputs [[a]]the control signal indicating the detected period by a signal level ratio, which is a ratio of a signal level of the second acoustic signal with respect to a signal level of the first acoustic signal; and

the spectrum ratio estimating section calculates the ratio of the second power spectrum with respect to the first power spectrum when the signal level ratio indicated by the control signal is greater than or equal to a threshold value.

Claim 7 (Currently Amended) The howling suppression device according to claim 1, wherein the suppression filter section filters the first acoustic signal by a Wiener filter method based on the first power spectrum and the second power spectrum, so as to output only an acoustic signal of the target sound to the amplification section.

Claim 8 (Currently Amended) The howling suppression device according to claim 1, wherein the suppression filter section filters the first acoustic signal by a spectral subtraction method based on the first power spectrum and the second power spectrum, so as to output only an acoustic signal of the target sound to the amplification section.

Claim 9 (Currently Amended) A computer-readable recording medium having a howling suppression program recorded thereon, the howling suppression program executed by a computer for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the howling suppression program causing a computer to execute a method comprising:

 a first power spectrum information producing step of producing a first power spectrum according to a first acoustic signal output, as an electric signal, from the first microphone that collects a sound and converts the sound into the electric signal;

 a second acoustic signal obtaining step of obtaining a second acoustic signal that is an electric signal of a sound including at least the intensified sound and not including the target sound;

a second power spectrum information producing step of producing a second power spectrum according to the second acoustic signal; and

_____ a learning control step of, based on the first acoustic signal and the second acoustic signal, detecting a period in which (i) the first microphone is not collecting the target sound, and (ii) the second acoustic signal is indicating the intensified sound or a reverberating sound of the intensified sound, and of outputting a control signal indicating the detected period;

_____ a ratio storing step of storing, in a ratio storing section, a ratio of the second power spectrum with respect to the first power spectrum;

_____ a spectrum ratio estimating step of calculating the ratio of the second power spectrum with respect to the first power spectrum when the control signal indicates the detected period, and updating the ratio stored in the ratio storing section according to a predetermined method using the calculated ratio; and

_____ a suppression step of (i) estimating a sound component, other than the target sound, that has been mixed in the first acoustic signal, the sound component that has been mixed in the first acoustic signal being estimated by using the first power spectrum, the second power spectrum, and the ratio stored in the ratio storing section, and (ii) suppressing the sound component in the first acoustic signal so as to output only an acoustic signal of the target sound to the amplification section filtering the first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.

Claim 10 (Currently Amended) An integrated circuit for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section

and outputting the amplified sound as an intensified sound from a loudspeaker, the integrated circuit comprising:

a first power spectrum information producing section for receiving a first acoustic signal output, as an electric signal, from the first microphone that collects-collecting a sound and converts the sound into the eclectic signal, and for producing a first power spectrum according to the first acoustic signal;

a second power spectrum information producing section for receiving a second acoustic signal that is an electric signal of a sound including at least the intensified sound and not including the target sound, and for producing a second power spectrum according to the second acoustic signal; and

a learning control section for, based on the first acoustic signal and the second acoustic signal, detecting a period in which (i) the first microphone is not collecting the target sound, and (ii) the second acoustic signal is indicating the intensified sound or a reverberating sound of the intensified sound, and for outputting a control signal indicating the detected period;

a ratio storing section for storing a ratio of the second power spectrum with respect to the first power spectrum;

a spectrum ratio estimating section for calculating the ratio of the second power spectrum with respect to the first power spectrum when the control signal indicates the detected period, and updating the ratio stored in the ratio storing section according to a predetermined method using the calculated ratio; and

a suppression filter section for (i) estimating a sound component, other than the target sound, that has been mixed in the first acoustic signal, the sound component that has been mixed in the first acoustic signal being estimated by using the first power spectrum, the second power

spectrum, and the ratio stored in the ratio storing section, and (ii) suppressing the sound component in the first acoustic signal so as to output only an acoustic signal of the target sound to the amplification section filtering the received first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.

Claim 11 (Currently Amended) A howling suppression method for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the howling suppression method comprising:

a first power spectrum information producing step of producing a first power spectrum according to a first acoustic signal output, as an electric signal, from the first microphone that collects collecting a sound and converts the sound into the electric signal;

a second acoustic signal obtaining step of obtaining a second acoustic signal that is an electric signal of a sound including at least the intensified sound and not including the target sound;

second power spectrum information producing step of producing a second power spectrum according to the second acoustic signal; and

a learning control step of, based on the first acoustic signal and the second acoustic signal, detecting a period in which (i) the first microphone is not collecting the target sound, and (ii) the second acoustic signal is indicating the intensified sound or a reverberating sound of the intensified sound, and of outputting a control signal indicating the detected period;

a ratio storing step of storing, in a ratio storing section, a ratio of the second power spectrum with respect to the first power spectrum;

a spectrum ratio estimating step of calculating the ratio of the second power spectrum with respect to the first power spectrum when the control signal indicates the detected period, and updating the ratio stored in the ratio storing section according to a predetermined method using the calculated ratio; and

a suppression step of (i) estimating a sound component, other than the target sound, that has been mixed in the first acoustic signal, the sound component that has been mixed in the first acoustic signal being estimated by using the first power spectrum, the second power spectrum, and the ratio stored in the ratio storing section, and (ii) suppressing the sound component in the first acoustic signal so as to output only an acoustic signal of the target sound to the amplification section filtering the first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.